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Globalization Shifts in Human Capital and Innovation

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Current competitiveness policy recommendations follow a well-worn path of calling for increases in U.S. science and engineering capacity through better science and math secondary education, supporting R&D by U.S.-based firms, colleges and universities, and providing various tax incentives. Although these policies may have been effective in the past, the current structure of globalization and competition change the fundamental basis on which nations will achieve economic prosperity in the future. In particular, strategies with the goal of U.S. dominance of global innovation or human capital supply may be outmoded. These “technonationalist” perspectives are based on a view that innovation, science, and technology are zero-sum and thus nations must necessarily compete to dominate these areas. Our analysis of structural shifts in human capital flows, innovation, and firms leads us to reevaluate the potential effectiveness of past strategies for current realities, in what we term “third generation globalization.” Further, this analysis provides insight into what industry needs from its science and engineering (S&E) workforce in the U.S., and the implications for K-12 education.

This brief addresses the nature of globalization and these structural shifts, the implications for education, and an alternative approach to policy based on “collaborative advantage.” National policy to achieve collaborative advantage follows from our analysis that no longer can the United States, nor any nation, maintain a position as global technology hegemony. The new emerging economies are an order of magnitude larger than those that emerged a generation ago—and they are today’s growth markets. Nor does the United States, despite its undeniable strengths, enjoy global dominance across the range of cutting-edge technologies. Moreover, U.S. multinationals are weakening their national identities, becoming citizens of the countries in which they do business and providing no favors to their country of origin. This means that the goal advocated by some U.S. policymakers of having the United States regain its position of leadership in all key technologies is simply not feasible, nor is it clear how the United States would retain that advantage when its firms and workforce are only loosely tied to the country.

Given these changes, which are historically disjunctive, we argue that pursuing policies once successful are not only likely to be ineffective but could potentially be detrimental. “Collaborative Advantage” is a policy framework for the United States to develop its strengths as a “strong node” in a network of nations that have strengths equal to or better than the United States in any number of technology and innovation areas (Lynn and Salzman, 2006). Rather than compete for human capital, or control of technology or innovation, the United States should develop its strengths as the best collaborator for other nations and companies. We propose a number of specific polices and an overall policy direction that support collaborative advantage. In brief, it is an approach that builds strength through participating in the “global commons” of human capital and innovation, and that achieves economic growth and prosperity through mutual-gain
strategies. The United States is currently the best positioned country, we argue, to do
this, because of its history of openness, diversity, and free flow of knowledge and be-
cause it is home to companies that are now the leading navigators in the new global
system. Learning how to maintain economic strength in this new world order, how-
ever, requires new policy approaches.

The research on which this analysis is based addresses the changes in global technol-
yogy development (Lynn and Salzman, 2007), the skills and supply of scientists and en-
gineers (Lynn and Salzman, 2002), and international education performance (Lowell
and Salzman, 2007). In this brief I will first outline the key elements of current com-
petitiveness and science and technology policy proposals, review the evidence about
comparative U.S. educational weaknesses cited in these reports, then discuss our
analysis of third generation globalization and the implications of these changes for
education and policy. Finally, I present our alternative policy approach based on col-
laborative advantage.

Premises of Current Policy Proposals

Although the U.S. economy has been, in aggregate, a stellar performer among nations
over the past decade or more, a number of organizations and policymakers have
grave concerns about the ability of the U.S. to maintain its prosperity in the face of
new growing economies, and the emerging economies of China and India in particu-
lar. In addition, there is concern about the state of the education system, growing
income inequality, and jobs lost to offshore sites and companies. Current policy pro-
posals from a diverse group of organizations find consensus on several problems and
solutions. The first of these is the failure of the U.S. secondary education system to
produce students who can score at the top levels of international tests of science and
math, and the second is the failure of the higher education system to produce enough
scientists and engineers from the domestic stock of students entering college. Third,
to compensate for these deficits, the historical approach to expanding the S&E work-
force has been to rely on immigrants, but now the inflows of foreign students are in
jeopardy and the outflows of foreign-born graduates is further depleting the U.S.
workforce. Finally, the rising numbers of scientists and engineers in other countries,
China and India in particular, will give those nations an edge in technology innovation
that threatens U.S. prosperity.

These premises form the basis for current policy to improve science and math educa-
tion, encourage more students to enter science and engineering fields, change immi-
grantion policy, and promote R&D, among other more targeted policies such as
changes in trade and intellectual property (IP) protection. The goal is to maintain U.S.
global dominance of the supply of human capital and innovation and, more broadly,
pursue a “top of the value chain” approach to economic prosperity and national
“competitiveness.” The National Center on Education and the Economy (NCEE) report,
Tough Choices or Tough Times articulates this common proposition:

Those countries that produce the most important new products and services can cap-
ture a premium in world markets that will enable them to pay high wages to their citi-
zens. In many industries, producing the most important new products and services de-
pends on maintaining the worldwide technological lead, year in and year out, in that
industry and in the new industries that new technologies generate (NCEE, 2007; p.6).

The common prescription for maintaining a U.S. technological lead requires the nation
to “abandon low-skill work and concentrate on competing in the worldwide market for
high-value-added products and services,” and the low-skill work either going to devel-
oping, low-wage countries or being done by machine (NCEE, 2007; p.4). Thus, more
education and a shift to “creative work” and high-value-added activities in products and
services are the cornerstone of policy recommendations based on these scenarios of
the future.

An Empirical Review of the Claims

We review three major claims underlying the concern about the competitiveness of the
U.S. science and engineering workforce, which are:

- Low performance of primary and secondary students in science and math,
  both in actual achievement levels and in comparison to that of students in
  other countries;
- Weakening interest in S&E fields by U.S. college students; and,
- A decline in the number of U.S. students pursuing S&E careers.

A review of the best available data, and of the reports on comparative student test per-
formance, raises questions about whether the conclusions of these policy proposals are
adequately supported by the empirical evidence. Our concern is that misinterpreting
the data can lead to misguided policy proposals.

Overall, we find that international testing does not show U.S. students, on average, to
be at any particular disadvantage to those in other countries. At the same time, over
the past several decades test scores have not shown dramatic change: there have been
increases in most math scores, and mixed results in science, especially of twelfth grade
science scores. In terms of labor market demand, the supply of secondary school stu-
dents with the requisite skills appears to be adequate and universities are graduating
scientists and engineers in numbers far in excess of labor market demand. However,
although relative levels of average achievement may be better than often reported,
there is a large proportion of the student population with significant educational defi-
cits.

We suggest that evidence-based policy would lead to different conclusions and recom-
mendations from those of current policy proposals in three respects:

- Attention should be focused on the large segments of the population that are
low performers since the comparative performance of the upper proportion of students is not at a disadvantage to those in other countries;

- More attention should be focused on the reasons why the labor market is not inducing more qualified college graduates to enter S&E careers rather than focus on increasing the supply of scientists and engineers; and,

- Policy should take a broader focus on labor force performance that considers the potential productivity gains by improving the education and skills of lower-skilled workers (e.g., IT user skills may affect productivity as much or more than the inherent capabilities of the technology and of those developing the software and hardware).

**Low Performance of Primary and Secondary Students** - Over the past several decades, the evidence does not suggest a precipitous decline in academic performance. Students have been increasing the amount of science, math, and language courses they are taking (see Appendix, Table 1A), and for the most part their test scores show steady if only slight improvement (Appendix, Table 1B). Math test scores for high school seniors have held steady, though in science they recently show a slight decline. SAT and ACT scores also show steady increases, though there was a very slight drop in the most recent SAT scores (Appendix, Table 1C). Although high school senior test scores do not show the steady improvement of other grades, test scores for these students are difficult to interpret and caution should be exercised in drawing any conclusions based on changes in these particular scores[3]. Importantly, average scores trends may be less important than the distribution, or performance of different segments of the population and the actual levels of performance. For example, in both math and science, rather large portions of the students do not demonstrate basic proficiency in these subjects. And, to the extent that scores improve, it tends to occur among those who are already high performers (Appendix, Table 1D).

In comparison to other nations, the U.S. does quite well on average but not as well in compensating for non-school, achievement-related disadvantages (e.g., single-parent and non-English speaking households). There are two international tests most often cited: the TIMSS and the PISA. In both tests, the rank order of test scores is often cited, but when examining the statistically significant differences in scores, we find the U.S. consistently places in the second tier across all grades, tests, and years of testing. The first tier group is composed of a changing membership (depending upon the test, year and grade) of mostly small nations, few of whom consistently outperform the U.S. across all tests, years, and grades, and almost none of whom show the same consistency or improvement in performance as that of the U.S. That is, with the exception of a few Asian nations (notably Singapore with a population of 4.5 million), no country has students that perform above the U.S. average in every test, every grade, and every year. Even the leading Asian countries fail to outperform the U.S. in non-science and math subjects such as reading and literacy. For example, a country may be part of the leading group in fourth grade math but in the lowest group in fourth grade science; or in the leading group of eighth grade math in one year but decline to the second tier group in a subsequent test (see Appendix, Table 2A). Consistent levels of performance across grades and subjects may be more important than stellar performance in one subject, grade, or year.
Further, an analysis of comparative performance shows that it is largely factors such as the high rates of poverty, single-parent households, and non-English speaking households of the U.S. population that account for lower test scores. This does not mean that the U.S. school system is doing well; in fact, these tests show that U.S. schools do a poor job at compensating for non-school achievement factors. U.S. schools have greater challenges to address than in other countries (children from more disadvantaged backgrounds such as single-parent household, non-native language speaking household) and less ability to address these problems at a system-wide or federal level (given the decentralized nature of U.S. educations systems). At the same time, many argue that the U.S. economy benefits from an open immigration system and the general openness of U.S. society. The tradeoffs should be considered when drawing international comparisons of the need to provide resources to address the negative impacts of otherwise positive policies of the United States. Thus, when drawing international comparisons, one cannot conclude that it is the school systems of other countries that lead to better performance. In Canada, for example, the immigrant population does not perform much differently from the Canadian-born students but this most likely reflects Canada’s restrictive immigration policy, not its school system. In fact, the PISA researchers conclude that their test measures the effect of non-school achievement factors such as poverty levels and single parent households (the latter are associated with lower scores and the U.S. has 33 percent of its school-age children in single-parent households as compared to less than 10 percent in nearly all other countries)[4]. In addition TIMSS and PISA have significant methodological limitations that suggest an abundance of caution in drawing conclusions about the relative performance of different education systems.

International testing shows that a large country with a highly heterogeneous population, including negative factors, such as high rates of poverty and single-parent households, and presumably economically positive factors, such as an open immigration policy, can be expected to have lower average test scores. The implication for education policy is to focus on a targeted effort at improving schools that serve the low-performing populations to minimize the educational impact of non-school factors.

We also ought to be cautious about drawing strong conclusions from the education rankings about the future competitiveness of America’s science and engineering workforce, when we consider that countries such as China and India would score abysmally low if tested (e.g., with 39 percent illiteracy in India and less than 50 percent secondary school enrollment), yet we know that, given their large populations, they can produce large numbers of highly trained scientists and engineers. Clearly, comparative education measures provide only a partial assessment of a nation’s ability to develop its science and engineering workforce.

Weakening Interest in and Declining Pursuit of S&E Careers - The claim that U.S. students show declining interest in science and engineering fields, either in college or in the workforce, is not reflected in the data. There was a one-time dramatic “Sputnik Spike” of students entering S&E fields in the early 1960s, followed by a sharp decline and then a gradual increase beginning in the mid-1970s and continuing until today (see Appendix, 3A). The actual numbers of S&E college graduates has increased over the past three decades and held steady in recent years (Appendix, 3B). The “continuation rate” of S&E Bachelor’s graduates going on to graduate school, following the early 1960s spike and then decline, has also remained at a steady rate for the past two decades (Appendix 3C). The major change since the 1960s, of course, has been the large increase in foreign-born students (on temporary visas) entering graduate school (Appendix 3D) and the workforce (Appendix 3E).
The global position of the U.S. may be changing but the data do not suggest that a precipitous decline in science, math, and engineering performance or an inability to educate large numbers of qualified scientists or engineers is the cause. At the same time, the large numbers of low academic performers should be a cause for concern and the focus of competitiveness policy.

**Structural Changes in the Global Economy**

What is now apparent is that there has been a disjunctive change in how nations participate and/or compete in the global economy. As a consequence, new approaches to policy are necessary, including a much broader education approach than narrowly focusing on math and science education or increased production of S&E graduates.

There are three important structural changes involved in the globalization of innovation: human capital flows; organizational form, structure, and functioning; and an “innovation shift”. These lead to a change in global “geographical stickiness” – that is, the entrenched economic and technological advantages certain geographic locales once enjoyed.

**Changes in Human Capital Flows** - The internationalization of U.S. graduate education and the workforce has occurred over at least the past 20 years. Students on temporary visas (recent immigrants) have generally comprised between 20% and 50% of graduates of science and engineering graduate programs (with a few exceptions, such as petroleum engineers which have over 75% foreign student graduates) since the late 1980s (Appendix 4A for 1995 and 2005). Some programs such as IT-related programs, experienced sharp spikes in foreign student graduates in the late 1990s, but for most programs there has been a slow increase or constant rate over the past 20 years. Over this period, these graduates have entered U.S.-based firms and now comprise a significant proportion of the science and engineering workforce in particular occupations and industries (Appendix 3E). A number of these scientists and engineers have now moved into senior technical and middle- and upper-level management positions. These workers have the experience, familiarity, and linkages to facilitate the location of science and engineering work globally. This global human capital “capacity” interacts with two other structural changes, in organization and innovation.

**Changes in Organizational Form, Structure, and Functioning** - Historically, firms tended toward ever greater integration of activities and functions. They also were firmly rooted in the “home” geographies, thus conferring an alignment between a firm’s economic performance and that of the nation in which it was based. But in the late 1980s and through the 1990s, firms began to be less geographically “bounded.” Outsourcing began as large firms began buying, rather than making commodity parts in, manufacturing enterprises in the 1980s and eventually expanded to the external acquisition of innovation and high value-added functions. This change in innovation strategy occurred throughout many industries and, in a remarkable shift, firms are now considered by Wall Street to be weak if they rely on strong internal R&D rather than external acquisitions of companies, innovations, or technologies. This change in organization form, of de-integration, and of innovation strategy, is the foundation for the global diffusion of innovation we are now witnessing. An international workforce provided the means by which this globalization is occurring. (It is argued that the more integrated organizational form and less international workforces of European or Japanese firms slowed their globalization, especially of high-level activities.)
Changes in the Nature of Innovation Activity - We identify at least three types of innovation shifts that provide advantages to the emerging economies. First, in areas such as some IT products and services, the initial offshoring of low-level activity [e.g., Y2K remediation] led to the development of highly structured and systematized methods. Formal software development methods and procedures (such as the Capability Maturity Model Integration [CMMI] method) were used by offshore companies to establish credibility as well as develop systems that could be staffed by relatively low-skilled programmers and analysts. Offshore locations required teams to communicate across long distances and asynchronous work shifts, thus necessitating greater formalization of software development procedures. As these IT technologies become mature, they follow a common technology trajectory of shifting innovation focus to process rather than product development. Process innovations potentially lead to greater reliability and maintainability, such as the advantages the Japanese first achieved in automobiles through improved manufacturing methods.

The second innovation change is in the types of innovation that come from local context. In previous stages of globalization, local innovation was confined to adaptation of existing products to local conditions. Now, we find that local innovation for local context is producing leading-edge innovation with global applications. Firms often adapted technologies developed in advanced industrial economies for use in developing economies, but rarely did those adaptations lead to innovations that were applicable outside those countries. And rarely were those local adaptations at the innovation frontier. Now, we find, engineering and technology development in emerging countries, often for multinational firms, is addressing local conditions but with advanced technology, and is addressing problems that have global applications. Perhaps the most important example of this phenomenon is “engineering under resource constraint”: engineers in the emerging economies appear to be more focused on products that are viable at large scale with limited or in expensive energy or materials, such as when developing heating, cooling, and transportation technologies. Technologies developed to heat northern China or provide efficient transportation for a billion people are likely to involve quite innovative technology.

Finally, there is a dual innovation frontier developing. In the past, typically only high-end innovation pushed the technology frontier. Now, it appears that low-end innovation may provide opportunities for new technology development and high profit. For example, the high-end iPhone is predicted to capture something less than 1 percent of the global market (under 10 million units) whereas an innovative cheap cell phone has potential sales in the hundreds of millions (China Telecom is already the largest cell phone company in the world with an estimated 300 million subscribers).

While each of these new forms of innovation is particularly suited to emerging economies, it is important to note that innovation in the emerging economy sites may be conducted in local or foreign-owned firms. Conversely, innovation developed in a company’s home country in the advanced industrial nations may be transferred to locations elsewhere in the world.

It is the confluence of these structural shifts or changes that define the current nature of globalization of science and technology. Changes in human capital flows, for example, reflect the changing global opportunity structure, probably more than visa policies. We find some evidence that innovation may be less geographically “sticky”, that is, less confined to only certain geographies such as Silicon Valley. Conversely, human capital may be becoming stickier, as people are less likely to move permanent residence for marginally different opportunities. Policy proposals that don’t reflect this new reality may
prove ineffective and perhaps detrimental.

**An Alternative Proposal—Collaborative Advantage**

The challenge that follows from our analysis is to craft policies that ensure the U.S.’s economic vitality and that provide a “return on investment” from public expenditures. If our analysis is correct, then current technonationalist policies are bound to fail in today’s world. Their proponents overlook two major developments. First, the dissolution of the company/country alliance means that innovation undertaken by a particular company will not necessarily return value to its country of origin. Second, the global diffusion of high-end work by firms, along with the globalization of universities, has increased the capacity of emerging economies to develop human capital. It will thus be increasingly difficult for any one geographic location to capture or dominate the supply of high-skilled and talented human capital. These changes in the global economy undercut the effectiveness of technonationalist policies: public investments that formerly provided clear return to a country, such as in company R&D or universities, will not necessarily return the value primarily to the country making the investment.

Science and technology policy can best enhance U.S. “competitiveness” in this new global system through an approach based on “collaborative advantage” (see Lynn and Salzman, 2006, 2007). In this approach, the U.S. would build on its strengths as one of the world’s most open and diverse societies and one that participates in, rather than impedes, global flows of human capital, knowledge, and innovation. Assuming that, for the most part, these are not zero-sum, the challenge is to formulate policies that “capture” value from participating in the global commons while achieving mutual gains for all participating countries. In this respect, it parallels the strategy of leading firms competing in open innovation systems and under conditions of global differences/inequities in national systems (ranging from trade to differences in IP protection). This approach also requires R&D and related policies that reflect the needs of global markets rather than just “local” U.S. or advanced economy markets -- for example, policies that motivate innovations that are viable with limited resources such as energy.

There are several specific policies that support collaborative advantage and additional policies that will emerge from this approach. A balanced immigration policy would encourage the flow of complementary human capital that expands existing U.S. capabilities, rather than immigration that serves as a substitute for the domestic workforce. To obtain access to leading knowledge and innovation around the globe, the U.S. should establish collaborative international labs, similar to U.S. national labs but with participation and full access by supporting nations. These labs would be the most attractive places to work for scientists and engineers in emerging economies, thus bringing their knowledge to the global commons. U.S. universities should be encouraged to develop offshore locations that follow and expand the U.S. model of open access and free flow of ideas within and between public and private institutions. Over the long term, the U.S. will achieve far greater gains through participating in these types of open institutions rather than trying to develop U.S.-based institutions that exclude other nations and sequester knowledge for exclusive national use. Of course, it can and should require equal access and sharing from all participants. Finally, changes in the types of education provided and addressing educational inequities are also required.

**Implications for Science and Engineering Education**
This analysis of globalization has implications for both specific educational needs for scientists and engineers and broader educational directions. First, I review the types of specific skills and education that businesses need as reported by managers in technology firms (Lynn and Salzman, 2002). Second, I discuss the broader educational needs and goals implied by our analysis of global shifts in innovation and technology development and an economic strategy based on collaborative advantage. Finally, I raise questions about the policy recommendations that the U.S. workforce skill and education efforts can or should be focused on “top of the value chain” jobs and the implications of the U.S. position in the global economy.

**Skills Needed Today** - Over at least the past 10 to 15 years, organizational, technological, and business strategy changes have led to new skill requirements for engineers and other technical workers. The de-integration of technology activity requires engineers to work across organizational boundaries with suppliers. Products that incorporate tightly integrated technology of different types, such as electronic and mechanical, or different materials, require engineers to work across disciplines, often with engineers in different fields. Business strategy that places more emphasis on market-driven technology development also requires engineers to understand the business drivers as well as the technical drivers of product or service development.

These different boundary spanning skills and abilities are increasingly important, especially in firms that are systems integrators or are at the higher value-added part of the development chain. As one engineer (who was identified to us as a “high performer”) explained in an interview, he wasn’t the most technically excellent engineer, but he knew how to get help when he needed it and was well organized so his projects were completed on time. In our study of qualities that make a “good engineer,” we asked about skills of successful applicants for job openings.

One U.S. manager said that the day of the brilliant engineer who would lock himself in his lab and slide his findings out under the door was over. Another mentioned firing an engineer who was outstanding on the technical side, but disruptive to the organization. In the new world of globally distributed engineering, engineers have to be even more adept at “communicating.” This has become a “core” engineering skill. Managers typically replied that technical skills were fairly easy to find and not a distinguishing criterion between candidates. Rather, it was their ability to communicate their ideas, to work with others on a team and with non-engineers, and other related social skills. These skills reflect the changes in the nature of engineering work, ranging from greater teamwork, working across disciplines, and with customers, and interacting with customers and suppliers in developing and acquiring technology (Lynn and Salzman, 2002).

More recently, the global distribution of engineering has added another layer of technically adept, but non-technical, positions. The new global engineers and managers will be different from engineers of the past. For example, the new global engineers are very open to cosmopolitan experiences. Engineering managers at one firm mentioned recently hiring an engineer who was not outstanding by their technical criteria, but was enthusiastic about the company’s international activities. The managers were somewhat surprised by this young engineer’s global interests, especially that he would welcome a foreign assignment. Most of their technical staff had no interest in working overseas. This new breed of engineer proved to be a wonderful asset for the company because he was not just willing, but eager to accept assignments in emerging economies. At the engineering development site in China of a U.S. manufacturer of heavy electrical equipment we interviewed four managers. All were Chinese,
including one from the region where the site was located, and one was from Taiwan, but three had 
previously been international managers of the multinational in the U.S. and Europe. When asked 
about cultural issues, they responded in terms of the multinational’s culture, and recounted how they 
had to transfer that to their local site. It did not seem to occur to them that we might have been refer-
ring to cultural gaps between the U.S. and China, or between Mainland China and Taiwan. Increasingly 
the ability to span cultures and nations is a key attribute. In this respect, we found global engineers 
and managers were often not born in the U.S. though educated here. Their experience across cultures 
and mixed national identities allowed them to move easily between and manage across global sites of 
the company.

The U.S. science and engineering education system will need to provide a broad-based, multi-
disciplinary education that will instill communication skills and an ease at working outside of a narrow 
field of expertise or technical training. Employers in technology firms also value skills that come from 
cross-national experiences, which educators may need to incorporate as part of technical training.

**Education Requirements** - Solid math, science, and technology education is necessary to form the 
foundation of skills required by S&E workers. However, globally competitive education must go far 
beyond training technically competent graduates. A broad education that incorporates a range of 
technical, social science, and humanities knowledge is important for developing a globally competitive 
workforce (e.g., see Hill, 2007). In this, the U.S. may have an advantage over the emerging economies. 
Trying to compete on the basis of sheer numbers of technically competent scientists and engineers is 
untenable and probably not the basis for achieving sustainable economic growth. Further, it is unlikely 
that it is a deficit of technical skills in the U.S. that is leading to global diffusion of S&E work and innova-
tion.

Importantly, although small numbers of individuals who create breakthrough innovations are credited 
with the gains from the implementation of their innovation, it may be a mistake to focus so keenly on 
education targeting the upper reaches of the technical workforce. Underestimated in many analyses is 
the role of lower-level workers in achieving high productivity and economic growth. For example, al-
though innovating a better computer network server is important, it is the legions of network adminis-
trators and technicians that affect how much of the potential productivity gains are realized from the 
technology. Similarly, throughout many types of work, the skills and aptitudes of lower-level workers 
have individually small but cumulatively large impacts on the economy.

**A Different Model to Drive Policy** - Currently the policy debate has been framed around a misreading 
of the latest trends best illustrated in the *Tough Choices or Tough Times* report by NCEE. They view the 
U.S. future as depending upon maintaining a position at the “top of the value chain.” The NCEE’s illus-
tration of this scenario (Figure 1) seems to imply that in ten years most of the U.S. workforce will be 
employed in “creative work” with low-skilled jobs located in emerging economies or done by machine. 
This prescription errs in two respects. First, the workforce is unlikely to undergo a shift in its skill/job 
distribution of the magnitude implied by their diagram and analysis. The vast majority of the work-
force would appear to be in “creative jobs” by 2017 in their scenario, whereas currently the vast major-
ity of the workforce are in jobs far from their “creative” diamond of the U.S. workforce. Wal-Mart 
alone employs 1.2 million workers, with most earning less than $10 an hour. Restaurant and retail 
workers combined constitute the largest employment grouping in the U.S. labor force. Science and 
engineering jobs, for example, comprise only 5% of all occupations, and even in highly technology-
based industries such as electronics or aerospace the S&E workforce is well under 50%, and only in computer systems design and architectural and engineering services does it exceed half of their total workforces (57% and 58%, respectively; see Appendices 5a-c).

Secondly, this scenario assumes that the U.S. can dominate innovation and creative work globally. Every indication from our fieldwork and review of current trends suggests it is highly unlikely that this work will be as geographically sticky as it once was. As discussed above, firms have largely abandoned this old model and are globally distributing all types of work within their firms. It is not clear how the U.S. could achieve the dominance in the NCEE model or advocated in many policy reports when firms increasingly have “top of the value chain” work globally distributed.

The alternative model is a strong-node network model. In this model, the U.S. is one of a number of nodes whose strength is built by alliances and collaboration. It assumes that innovation and economic growth are not zero-sum but, rather, that mutual gain can be achieved. Policies supporting this approach build on global circulation of human capital and developing ways to achieve returns from participation in the global commons (see Lynn and Salzman, 2006, 2007). One example would be the establishment of international labs that would provide the U.S. access to innovation in locations throughout the world. Just as firms are developing business strategies to profit from open innovation systems, so too should the U.S. develop competitiveness or economic growth strategies built on collaboration. The realities of global innovation systems and human capital flows require new science, technology, and competitiveness policies. Discussed here are some of the policies and types of education needed, but many specific initiatives still need to be developed under this alternative scenario for achieving national economic prosperity.

Hierarchical vs. Network Markets, and Workforce Distribution

...implies a global order of national hierarchies (such as that of the past):
Alternatively: strong-node network model to achieve collaborative advantage in the global commons.

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Footnotes

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2 The view that the U.S. needs to maintain a position of technological dominance is voiced by a number of leading policy reports such as that of the American Electronics Association, which states, “The United States can no longer take its technological dominance for granted.” (AeA, Losing the Competitive Advantage?), the Business Roundtable, which is concerned that “…our scientific and technological superiority — is beginning to atrophy…. We must not disregard our history nor forget who we are … If we take our scientific and technological supremacy for granted, we risk losing it,” (Tapping America’s Potential), or the Council on Competitiveness: “The United States faces an unprecedented challenge to its long-term global economic leadership. And a fall from leadership would threaten the security of the nation and the prosperity of its citizens.” (Innovate America). These views tend to equate technological or innovative strength with national dominance, superiority, and/or supremacy, implying that science and technology innovations are necessarily zero-sum.

3 Evaluating the average test scores of high school seniors is difficult because it appears that the composition of the population has also changed over time, now including more students who, in the past, dropped out of school before their senior year. Presumably those were the lower performing students who, now, are part of the population tested. Similarly, the recent decline in SAT scores was attributed to the larger and more diverse pool of test takers (e.g., the state of Maine required all high school seniors to take the test).

4 Many researchers have found non-school achievement factors to be strongly associated with educational performance levels. For example, the rate of single-parent families in the U.S. is two to three times the rate in the countries that have the highest test scores, and the impact on national test scores is strikingly large. “Even when controlling for the influence of other socioeconomic factors, an average gap of 18 scale points remains between students from single-parent and other types of families. This gap is between 25 and 30 score points in Belgium, Ireland, and the United States” (OECD 2004, p. 167). Analysis of the PISA results and socioeconomic factors shows that in some countries schools appear to offset the negative impacts to a much greater extent than in other countries. The United States is one of six OECD countries where socioeconomic level has a strong impact on student performance, or conversely, where schools are least effective in providing an education that improves the test performance of students from low socioeconomic, immigrant, and/or single-parent families (OECD 2004, p. 182).

Looking at the actual international differences in these factors shows how strikingly different the U.S. is from the countries with high average student scores. When we compare the United States with industrialized nations whose students test better, it is harder to ignore obvious differences. Single-parent households with children under age 17 account for 33 percent of families in the United States (U.S. Census 2006), compared with 17 percent in Norway (a country with comparatively high levels of social benefits and services) and less than 10 percent in Japan, Singapore, and Korea. Almost all of the population of Japan, 99 percent, speaks Japanese as their first language, compared with the 18 percent of the U.S. population that lives in a household in which a language other than English is spoken. Along these lines, consider that Norway, one of the top-scoring western nations, has a small population of 4.5 million with an immigrant population of just 7 percent, of which 44 percent is European (with relatively
similar social and cultural conditions and background). Although Canada has a foreign-born population of 18 percent compared with 11 percent of the U.S. population, Canada has a much more restrictive immigration policy, effectively limiting immigration to high-skilled workers, those establishing a business, and family members of those already in Canada. (Canada is one of the few countries in which natives do not significantly outperform immigrants [OECD 2004, 167].)